CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Lyra Alers

Project Number

J0301

Project Title

Reuse of Plastic Waste in Concrete Bricks

Abstract

Objectives

The point of this project is to see which type of plastic is best for replacing gravel in making concrete bricks. This can reduce the amount of plastic that ends up on in landfills. America has been transporting most of its waste plastic to China, but recently, China has stopped taking it. So we have no place to send our plastic trash other than landfills.

Methods

Standard concrete is a composite of portland cement, sand and gravel. This experiment replaced the gravel with different types of plastics chosen from the top 10 list of plastic trash. The five types of plastic trash tested were bottles, lids, straws, shopping bags and trash bags. Bricks were formed by mixing cement, sand and cut up plastic. The cured bricks were then tested for density, water adsorption, cracking-strength and drop-strength.

Results

The different type of plastic used changed the brick properties by a major amount. The control brick could hold the most amount of weight in the middle (85 pounds)relative to the plastic containing bricks where the bottle cap brick and the straw-made brick tied at 62 pounds. The least amount of water adsorption was the beverage bottle brick, gaining only 2.7 grams relative to the control brick, gaining 4.8 grams. The brick that got to the highest point in the drop test was the bottle caps brick, not breaking until it was dropped from 9 ft. The control brick and others broke with a 7 ft drop or less.

Conclusions

My experiment tested bricks made out of different plastics to see which would be the best relative to a standard concrete brick. Many different tests were performed including seeing how much weight it could handle, how much water is absorbed and how it can handle being dropped. My hypothesis was that bottle cap-made bricks will do the best in most tests because the bottle caps seemed the strongest plastic and when broken down seemed to mimic the gravel in the control brick the best. It ended up doing well in most tests. Out of the plastic-made bricks, the bottle cap made brick ended up being the best for strength in general, while the beverage bottle bricks were the best in absorbing the least amount of water and performed well in the drop test.

Summary Statement

Plastics waste can be used to replace gravel in concrete resulting in better concrete properties for some applications.

Help Received

I want to acknowledge my dad who helped with the cutting of the plastics and testing the bricks.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Vivienne Barrett

Project Number

J0302

Project Title

Hydraulic Powered Robotic Cardboard Arm

Abstract

Objectives

The object of my project was to design a hydraulic powered robotic cardboard arm that followed the commands of hydraulic mechanisms while was supported with three different structural support designs. When the arm was performing the tests, I would observe how much the arm was supported by the different supports and which ones helped the arm perform the best without much deflection. I observed that my hydraulic system could have been set up better due to lack of direct following of control commands. Also, to get more precise results to help me improve, I would have to design qualitative tests rather than quantitative tests.

Methods

Cardboard, syringes, tubing (I used rubber but plastic is better), wooden skewers, hot glue, popsicle sticks, coat hanger wire, box cutter, drill, zip ties, paper clips, ruler, water, food coloring (optional). Cut cardboard pieces to correct sizes, drill holes in pieces and attach to correct pieces using skewers. Drill holes in syringe and attach to arm, make popsicle stick levers and connect with syringes. Pump water into tubing and syringes insuring no air enters. Test with different structural designs to see which added the most support without deflection and follow a certain criteria.

Results

My results were that the wire structural design worked the best when supporting the arm, and the popsicle stick design worked the worst when supporting the arm. My original hypothesis was wrong because I believed that the popsicle design would work the best because of its strength and ability to support and add coverage to most parts of the arm, but I encountered a mistake. The skewers got in the way of the popsicle sticks so they couldn't provide complete coverage to the cardboard. The wire did the best because it could easily bend around this skewer obstacle. The cardboard got second place in support, which I imagined would do the worst because its lack of support. It was mainly just the control.

Conclusions

I would say my results did surprise me, but there is a lot to improve and change. I have learned a lot from this project, and not only from my tests but my research as well. In my research I have discovered the many ways hydraulics can be used in prosthetic arms and other limbs, not just as a mechanism that powers the whole design. I learned my project tested a couple variables that made the testing complicated when I should have been breaking it down into smaller chunks to test. Like testing the strength and deflection of the cardboard and other designs before hand and give me more qualitative results. I would also choose to use

Summary Statement

I created and designed a hydraulic powered robotic cardboard arm that was supported by different materials to increase the strength and efficiency of the arm.

Help Received

None. I designed and built the arm myself with inspiration from previous projects.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Ayaan Bhatkar

Project Number

J0303

Project Title

Minimizing Earthquake Damage for Buildings

Abstract

Objectives

The purpose of this project is to determine which variable (the mass, length of the damper and the amount of damping) causes the tuned mass damper to be the most efficient in minimizing damage caused by earthquakes.

I became interested in this idea when I was learning about the earthquake that hit Mexico on Sept. 19, 2017, I was wondering why there was so much destruction. I thought buildings were supposed to be stable but the buildings destroyed by the earthquake proved otherwise. I decided to do some research on how earthquake damage could be minimized. My science fair project provided me an opportunity and motivation to study up more on this.

In this experiment I found the most effective variables, in order to maximize the efficiency of Tuned Mass Dampers. This project will help decrease the damage done by earthquakes in the future. I had hypothesized that the bigger, and heavier the tuned mass damper the more it resists against the shaking; the less smaller, and lighter, it would resist less against the shaking.

I tested five different scenarios. In one scenario I had a plain building with no tune dampers, the second scenario was with a building that had a 12 inch tuned mass damper with 10 washers as the mass. For my third scenario I had a building with 12 inch tuned mass damper with 5 washers, for my fourth scenario I had a building with an 8 inch tuned mass damper with 10 washers. For my final scenario I had a building with an 8 inch tuned mass damper with 5 washers. I tested each scenario 10 times. I graphed each scenario and found the average for each one. I used the average to figure out the most effective Tuned Mass Damper. After the experiment I learned that my first hypothesis was wrong. The most effective Tuned Mass Damper was the 8 inch with 5 washers.

Based on my results, I concluded that too much mass overcompensates the effect of the tuned mass damper, and once you increase it beyond the optimal mass you will start seeing the benefits decrease in terms of minimizing the shaking. Also if the weight is too much the structure could get weakened which can cause it to collapse. My second hypothesis was correct, the building with no tuned mass damper was the most vulnerable.

Summary Statement

I showed that the damage to buildings when the ground shakes during an earthquake can be minimized by an efficiently designed tuned mass damper.

Help Received

My adviser guided me and my parents helped me buy the material needed for the model

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Heidi Bishop

Project Number

J0304

Project Title

Shake It Up: The Effect of Temperature on Building Materials During an Earthquake

Abstract

Objectives

The objective was to discover how different temperature building materials are affected during earthquakes.

Methods

I experimented with buildings of metal, wood, and plastic and a heat lamp and freezer made buildings hot or cold. A digital thermometer measured temperature as buildings were attached onto a shake-table. I shook the shake-table and recorded data using an accelerometer. Each building was placed in the freezer for 60 minutes. The building s temperature was taken; it was attached to the table, shaken, and data recorded. This repeated every 10 minutes until the building was back to room temperature. The procedure was then repeated using a heat lamp.

Results

For cold, the metal building s temperature ranged from 11°C to 21.9°C. Acceleration ranged from -18.4 to 19.8 m/s^2. For warm, it ranged from 22.3°C to 51.2°C. Acceleration ranged from -17.2 to 19.1 m/s^2. For cold, the wood building s temperature ranged from -10.0°C to 22.3°C. Acceleration ranged from -9.9 to 8.4 m/s^2. For warm, it ranged from 21.1°C to 81.6°C. Acceleration ranged from -17.8 to 10.5 m/s^2. For cold, the plastic building s temperature ranged from 0.9°C to 24.8°C. Acceleration ranged from -13.8 to 16.0 m/s^2. For warm, it ranged from 20.9°C to 32.5°C. Acceleration ranged from -12.9 to 14.5 m/s^2.

Conclusions

My hypothesis was that if the temperature of a building s material rises, then it will have more movement when shaken during earthquakes. Data showed metal and plastic buildings didn t follow my hypothesis and the wood building did, proving my hypothesis partially correct. Metal building moved most during earthquake simulation, but wasn t affected by temperature. Wood building moved the least, but showed more movement as temperature rose. Plastic building s results varied. Data led to the conclusion that wood buildings are affected by rising temperature during an earthquake. Metal buildings don t seem to be affected by rising temperature. Data for the plastic building was inconclusive.

Summary Statement

As measured by an accelerometer, I found that only one of the three building materials I tested was effected by temperature during a simulated earthquake.

Help Received

My parents provided the supplies needed for me to do my project and my grandpa helped me build the shake table.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Marcus Catanzaro

Project Number

J0305

Project Title

Rock and Roll Derailment: Reducing Harmonic Oscillation in Trains

Abstract

Objectives

This project was inspired by harmonic rock and roll derailment. Harmonic rock and roll derailment is when the rail car derails due to harmonic oscillation at its resonant frequency. Railroad tracks are made with a series of rails welded together and sometimes one rail is higher than another at the joint. If the train hits six pairs of misaligned joints in a row the rail cars will begin to rock. The faster the train travels on the rails, the higher the frequency of the excitation. The frequency of the resonance is determined by the mass of the rail car, and the spring stiffness of the rail car suspension. The goal of this project is to determine which has a larger impact on the acceleration at resonance: the mass of the rail car or the spring stiffness of the rail car suspension.

Methods

I tested my hypothesis by building a mechanical model of a rail car and using a homemade vibration platform to measure the acceleration response at resonance. Springs and test masses were used to create a mechanical model of a rail car. I built the vibration platform using an aluminum honeycomb plate suspended on springs and excited with an acoustic thruster. I created computer code to sweep frequencies and drive the thruster. The program also recorded the data from two accelerometers. The harmonic response was defined as the amplitude of the acceleration of the model divided by the amplitude of the acceleration of the vibration platform. Two different springs were used for suspension and each set of springs was tested with three different masses.

Results

The response below, at, and after resonance was collected for each configuration. The maximum height of the response was compared for masses or spring rates. When I added mass to my test object the resonant frequency was lower and the maximum response was also reduced. When I increased the spring rate, the resonant frequency increased, but again the maximum response was reduced.

Conclusions

When the spring rate is low, the responses for all masses were higher than the responses at higher spring rate. When the mass increased, the response decreased for each spring. I normalized the responses, the masses, and the spring rates to understand the relative effect of mass and stiffness. When I doubled the spring rate or the mass, the response cut in half. This indicates that the effect of mass and spring rate on the response is the same.

Summary Statement

I showed that the mass and spring stiffness of a rail car can be changed to reduce the harmonic oscillation in trains.

Help Received

None. I designed, built, and performed the experiments myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Justin Chen

Project Number

J0306

Project Title

The Portable Comfort Zone

Abstract

Objectives

When in a communal space, there is no control over the temperature. Having a portable device that can heat or cool can help those that are temperature sensitive have their own Portable Comfort Zone . I made this device because I started to notice how people were complaining about the temperature being too hot or cold for their liking. Therefore, I wondered if it was possible to make a portable heater and/or cooler.

Methods

Peltier thermoelectric semiconductor, fan, power source. Place the Peltier thermoelectric semiconductor in front of a fan, and connect both to a power source. Reverse the polarity of the electrical current to switch from cooling to heating.

Results

I collected the heating and cooling temperature (degrees) of the device over time (seconds). The highest heating temperature was 45 degrees after 120 seconds, and the lowest cooling temperature was 17 degrees after 90 seconds.

Conclusions

This prototype will allow better local control of the temperature for people who are sensitive to heat or cold. Next steps will be to make it smaller, lighter, and have temperature sensors to automatically turn it on and off.

Summary Statement

I built a portable unit that can heat or cool a the personal space for an individual.

Help Received

I discussed with my father the general concept. Then, I researched the internet to determine the components necessary to built the unit.

Name(s)

Catherine Demegillo

Project Number

J0307

Project Title

Comparing Grip Materials to a Cylinder Using a Hydraulic Arm

Abstract

Objectives

The objective of this study is to find grips that are affordable and effective so that the cost of prosthetic arms could be lowered while the effectiveness of the prosthetic arm could remain the same or even become more effective.

Methods

Materials that I used was a Hydraulic arm, 4 different grip materials, and a soda can. These materials helped me measure the effectiveness of different grips based on if the arm was able to hold the soda can or not.

Results

Grips that were stickier or stretchier were over 50% more effective than the grips that were more silk-like and slippery when holding the can. Several trials were recorded and the averages were the results. The results showed that the stretchier the material, the better.

Conclusions

In conclusion, multiple trials show that grips that were more stretchy were more likely to be able to hold the can than the grips that were slippery. This shows that my Hypothesis was on the right track and that there were other factors that I did not think about before that I needed to research in order to do the experiment. I have concluded that the grips that I have tested are more effective than those, more expensive material, used for prosthetic arms.

Summary Statement

I created a hydraulic arm that would be able to hold a soda can to test different grips that were less than $5 to find which materials were the most effective to help make prosthetic arms more effective and affordable at the same time.

Help Received

I designed the hydraulic arm myself, using a few different ideas I found online while I was researching and I also designed some of it myself. I built the whole arm by myself with no help.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Christian Felts

Project Number

J0308

Project Title

Determining Factors that Increase Speed in Pinewood Derby Cars

Abstract

Objectives

The objective of this project is to determine the efficacy of specific mechanical changes made to pinewood derby cars resulting in greater Kinetic Energy in order to increase speed.

Methods

Materials: Pinewood Derby Kits, graphite, scale that reads ounces, lead and tungsten weights and tungsten putty, aluminum track for testing, stopwatch. Tools included axle bending tool, mill, lathe and drill press. Methods: Built a baseline car to establish baseline speed. Using baseline car, made three incremental changes to car and tested changes to speed. Built two additional cars that started with the baseline car's parameters to test the impact of additional mechanical changes.

Results

Three pinewood derby cars were built and tested. A baseline car was built and tested on an electronic track. A second car with a different wheel base was tested, and a third car with an aerodynamic shape was tested on tracks that did not record speed. Results were obtained by estimating car length advantage. (The second car was tested against the baseline car to test the different wheel base, and the second car was tested against the third with the same wheel base.) With each car, modifications were made incrementally and tested (three times) to isolate and verify the impact of changes. The following parameters made pinewood derby cars faster: using graphite on the axles and wheels, using lightweight wheels and polished axles, lifting the left front wheel and bending rear axles also raised speed. A longer wheel base and aerodynamic shape improved speed. Using the maximum weight and weight placement towards the back of the car also increased speed.

Conclusions

Through testing, each mechanical change tested such as: weight placement, lighter parts, aerodynamic shape, and other changes to reduce friction resulted in making the pinewood derby cars faster. The results prove the scientific principle that reducing friction results in increasing Kinetic Energy and thus the speed of the car.

Summary Statement

I built three pinewood derby cars and tested various mechanical changes to the cars that resulted in increasing the speed of the cars.

Help Received

I researched articles on the internet and YouTube that directed me in putting together my test plan and validating the test results. I built the pinewood derby cars with my father overseeing the work on a mill, lathe and drill press.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Nicholas Frutos

Project Number

J0309

Project Title

Rocking the Boat

Abstract

Objectives

The objective of this science project is to determine what effect a pair of bilge keels provides for the stability of a boat in water.

Methods

Two 2-liter soda bottles, rubber cement, glass marbles (50-60), one wooden dowel (1 foot long), bathtub, stopwatch, double-sided adhesive tape. After constructing the boat, I attached two 5-centimeter bilge keels under the boat and placed the boat within a bathtub of water. After three trials, I cut one centimeter off of the 5-centimeter bilge keels and recorded the total time of the oscillations and number of oscillations the boat encountered.

Results

The longer the bilge keel length, the less total time of the oscillations and the less number of oscillations encountered by the boat.

Conclusions

Repeated trials demonstrate that longer bilge keels provide better stability for a boat in water.

Summary Statement

My science project demonstrates that longer bilge keels provide better stability for a boat in water.

Help Received

I constructed the boat and performed the experimental trials myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Jack Garza

Project Number

J0310

Project Title

The Effect of Weight on Flywheel Performance

Abstract

Objectives

The purpose of this experiment was to find out which weight would make the flywheel spin the longest.

Methods

Timer, 3D printer, computer, camera, tachometer, various fishing weights, a flywheel. Spun up flywheel, cut power, place tachometer over spinning flywheel, recorded spin-down time, repeat 5 times with varying weights.

Results

The average spin-down times were 55.14 sec for the 2 oz flywheel, 45.83 sec for the 1.5 oz flywheel, 35.28 sec for the 1 oz flywheel, 24.43 sec for the 0.5 oz flywheel, and 15.44 sec for the flywheel without added weight. The heaviest flywheel spun for 39.7 seconds longer than the lightest flywheel.

Conclusions

The increasing spin-down times as a function of increasing flywheel masses do support my hypothesis that if the flywheel is heavier it will spin for a longer time. By increasing the mass of the flywheel at the edge of the flywheel, I increased its rotational inertia. This in turn increases the energy of the spinning flywheel and causes it to spin longer. Although I was limited by the size of the 3D printer, I was able to maximize the amount of energy with the spoke design.

Summary Statement

I designed and 3D printed a flywheel that allowed me to test the effect of increasing flywheel mass on spin-down time.

Help Received

My Dad helped me set up the 3D printing and Steve Errea, a family friend, helped with the understanding of the application of flywheels.

Name(s)

Alexander Gianola Cook; William Hand

Project Number

J0311

Project Title

Measuring Optical Disc Storage Capacity

Abstract

Objectives

The objective of our project was to understand the relationship between the wave nature of light and storage data capacity by examining optical media using lasers.

Methods

Our methods rely on measuring the angle between diffraction points and using that angle and the known wavelength of the laser to determine the distance between the rows of pits on CDs and DVDs. We designed a styrofoam rig to hold a laser steady at a fixed distance from the discs which were positioned under the laser. We then mapped the diffraction points on a protractor template and recorded their degrees of diffraction. We tested each disc using both a red and blue laser. After data collection, we calculated the distance between the rows of pits on each of the discs. We then took the average for each disc for both the red and blue laser readings to compare results.

Results

We found that DVDs have less distance between the rows of pits than CDs. A DVD had an average distance between pits of approximately 723nm and a CD had an average distance of approximately 1451nm.

Conclusions

We concluded that because there was less distance between the rows of pits on the DVD than the CD, the DVD has greater storage capacity. This finding is consistent with our hypothesis that DVDs would have a higher storage capacity than CDs because the pits on DVDs are created by a laser with a narrower wavelength than that used to create a CD.

Data storage is in high demand as more and more digital data is created. Optical data storage has been limited by the physical size of the disc and the width of the light beam. Scientists are trying to increase optical data storage on optical media either by using discs made of materials other than plastic such as glass or crystal or using light beam techniques to try to create smaller pits on the plastic discs. Our experiment helps other to understand how the sizes of wavelengths are associated with data storage capacity. By applying what we have learned, others can expand on that knowledge to figure out how to increase optical data storage capacity.

Summary Statement

We measured the data on optical discs using red and blue lasers.

Help Received

A relative explained how DVDs and CDs are created by lasers.

Name(s)

Aadit Golwala

Project Number

J0312

Project Title

Offshore Floating Wind Turbines: Reducing Complexity and Cost by Turning the Entire Structure into the Wind

Abstract

Objectives

Design and build a prototype offshore floating wind turbine that turns the whole structure into the wind using only the power of the wind.

Methods

Built an inverted 3-sided pyramid out of PVC pipe as the base of the structure. Another pyramid made of carbon fiber rods attached on top of the PVC pipe pyramid. A DC motor with a propeller was attached to the top. Pipe insulation served as floatation. Chain with a weight attached served as an anchor. Fin made of foam fixed to the back of the prototype. Turned on a fan at 3 different speeds to test whether the turbine could turn into the wind. Created 2 centimeter high waves to test if the prototype stayed afloat.

Results

Tested 2 prototypes for stability and the ability to turn into the wind. The first was highly unstable and sunk all 5 times in the stability test. It failed the direction test and sank 3 out of 5 times. The second prototype had many improvements. It successfully passed the stability test for all 5 trials. The entire structure turned directly into the wind all 5 times for the direction test. The structure was also able to turn at all 3 tested speeds.

Conclusions

I built a prototype offshore floating wind turbine that floated and stayed stable, while successfully turning into the wind. The entire structure was able to turn into the wind at three wind speeds and was able to stay stable during the wave test. Most wind turbines turn the nacelle, a housing for the turbine, into the wind to get more energy. My design turns the whole structure, not only the nacelle. This moves the turning point to a lower plane, the sea. This also increases the durability and strength of the overall structure which reduces the complexity and therefore the maintenance cost.

Summary Statement

I built a working prototype of a simpler and cheaper offshore floating wind turbine that turns the whole structure into the wind using only the power of the wind.

Help Received

None. I designed, built, and tested the idea on my own.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Jake Grigorian

Project Number

J0313

Project Title

Which Robotic Apparatus Toggles a Flag the Most Efficiently?

Abstract

Objectives

The objective of my project was to determine which of the three robotic apparatuses that I designed, built and programmed would perform the best in accuracy and speed in launching a ball at a plastic flag and toggling it. I hypothesize, that the Plate-Punt Slingshot apparatus will perform the best in toggling the flag.

Methods

Body of VEX Robot, materials for three different robotic apparatuses (Plate-Punt Slingshot, L-Shaped Slingshot, High Friction Flywheel), yellow VEX ball, plastic VEX flag, joystick, competition field (area of testing). I coded the program for joystick and robot function and used my stopwatch. Designed, built and programmed the three apparatuses. Respectively attached each robotic apparatus to the body and had it load and fire the ball at the plastic flag. Tested each apparatus ten times and averaged the results.

Results

After ten trials for each robotic apparatus, I averaged the results. I determined that the Plate-Punt Slingshot had the fastest average speed, 3.11 seconds and highest accuracy,100%, of the three apparatuses in toggling the flag with the ball. This meant that it was the most efficient at performing the task at hand as compared to the other apparatuses (L-Shaped Slingshot 3.3 average seconds, 80% accuracy, and the High Friction Flywheel 3.592 average seconds, 90% accuracy).

Conclusions

I designed and built three robotic apparatuses, which are the Plate-Punt Slingshot, L-Shaped Slingshot, and High Friction Flywheel, and attached each individually to the body of the robot and programmed and commanded it to load and fire the ball at the flag. After determining that the Plate-Punt Slingshot was the most effective apparatus, it can be concluded that it is the most efficient apparatus out of the three.

Summary Statement

I designed a robotic apparatus, currently being used in robotics competitions, that is the fastest and most efficient in its category.

Help Received

I designed, built, and programmed, the robot and its apparatuses, and also performed the trials by myself. St. Francis High School provided the materials and field to perform my trials.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Abhinav Harikrishna; Tanish Swarnapuri

Project Number

J0314

Project Title

Need a Hand? Arduino-based Prosthetic Hand

Abstract

Objectives

Our goal is to build a low-cost prosthetic hand to perform certain pre-defined hand movements.

Methods

Arduino Uno R3, USB cable, Laptop Computer, Arduino IDE, C++ Code, Yarn, Duct Tape, Hot glue, Breadboard, Jumper wires (single sided and double sided), Servo Motors, Remote Controller, IR Receiver, Plastic straws, Cardboard.

Results

Based on the experimental data, the hand can perform certain grips and movement for object relocation. If the object size is above 50% of the prosthetic hand model, the grips are successful. The prosthetic hand had challenges to grip smaller objects. Some of the more sophisticated grips were also not possible given the limited degrees of freedom (up to 4) of the design. By using 3d printed hand design we achieve more complex hand movements and very sophisticated hand grips such as Tripod grip.
The brainwave signals capture by the neuro recorder is very basic. This is because the brainwaves for hand motions are very weak signals and the recorder we used couldn t capture that well. With a more expensive commercial neuro recorder we can capture the hand movement related signals in a better way.

Our hand model and experiments prove that a low-cost prosthetic can be designed to mime bionic hand. However, it needs more revisions of the product to make it useful in day to day life.

Conclusions

The Arduino Prosthesis is a low-cost alternative to commercially available prosthetic hand. As the components are not expensive, it s very easy to go for multiple iterations in its design and complexity. It can be expanded by adding more controls, 3d printing the hand and fingers, incorporating touch sensing and force sensing. Also since the components are plug and play it can be quickly replaced and rest of the arm can be repaired or restored to its original specifications.

We hope to recreate the human limb through robotics and engineering to make a bionic hand. We hope to learn about prosthesis and how the arm is being run by brainwaves from the EEG, and how to code in python for the Arduino. We would like to continue working on v2.0 and beyond to make the hand smart enabled, sophistication in the finger movement and more receptive to brain EEG.

Summary Statement

Build a low-cost prosthetic hand to perform certain pre-defined hand movements

Help Received

My project mate and I designed and built all prototype prosthetic hands. My Mom helped me with programming Arduino.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Parker Harris

Project Number

J0315

Project Title

Protective Barrier for Classrooms

Abstract

Objectives

The objective was to create a bulletproof collapsible wall that could be fully extended if there was an incident of an active shooter in a classroom setting at a school.

Methods

I made a panel out of various materials to see if it could stop a bullet. I did a test with four guns and five trials per gun on the material I engineered. I have also designed a collapsible wall to protect students and faculty.

Results

The concept of the foldable wall was applicable. The materials that I engineered needed to be able to stop bullets was a success because the material was able to take the impact of the various bullets.

Conclusions

The protective barrier for classrooms was able to be applied to its task. The unique bulletproof panel I engineered was a success due to it stopped the impact of the bullets.

Summary Statement

I engineered a collapsible wall that could pull across a classroom to protect students from rouge bullets in a case of an active shooter.

Help Received

A 10 year shooter veteran and a USPSA hand gun competitive shooter carried out the part of my experiment that involved shooting, my teacher educated me in the scientific method, and my Dad provided additional help in my project.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)	Project Number
Ishan Juluri	J0316

Project Title

The Effect of Tuned Mass Dampers on Oscillating Buildings

Abstract

Objectives

Skyscrapers are one of the most vulnerable buildings to suffer in an earthquake. The moving ground causes the building to vibrate at destructive levels. The objective of my project is to see how Tuned Mass Dampers (TMDs) can help a building quell extra oscillations after earthquakes or strong winds.

Methods

A 24 inch tall building was constructed. Then, a pendulum was attached to the bottom of the roof. An accelerometer was attached to the top of the roof. Attached to the wires running down from the accelerometer was an Arduino. The Arduino was attached to my laptop. The Arduino's purpose was to capture the data coming from the accelerometer and then translate it into a readable format. To tune the pendulum, I tightened or loosened a screw in the pendulum's coupling bracket. To mimic motion in the building, I attached a bungee cord to a hook in the bottom of the building and then to another hook in a piece of wood, I placed two pieces of wood, to stop the building abruptly. To stop the building from toppling over, two bricks were used as a counter balance.

Results

The result of this experiment proved TMDs did reduce oscillations in a building. The building with a tuned mass pendulum s oscillation reduced by nearly 70%. A 50% drop was measured in the oscillating amplitude of the building.

Conclusions

The results of my experiment support my hypothesis that tuned mass pendulums help prevent catastrophic shaking in buildings during earthquakes. This happens because the pendulum acts as a counter balance. When the building leans one way, the pendulum swings the other way. Thus, the building outfitted with a tuned mass pendulum effectively stops oscillating much faster with less amplitude.

Summary Statement

My project is on the effect of Tuned Mass Dampers on oscillating buildings.

Help Received

Dr. Ismail explained the concept of resonance and how it relates to earthquakes and building motion

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Samantha Kilmer

Project Number

J0317

Project Title

Shake It Off

Abstract

Objectives

The objective of this project is to identify which building results in an architecturally earthquake-proof design, minimalizing shaking on each floor.

Methods

First, make 4 buildings using balsa wood and cardboard. One of them will have an 8 by 8 bottom, one will have a 6 by 6 bottom. The last two will have a four inch by four-inch piece of cardboard. Next, dissect an R/C car. Keep the direct current motor(D/C), the on/off switch, and battery pack. Solder the wires to the D/C motor, battery pack, and on/off switch. Glue the three components to one of the 2, 10 x 10 pieces of plywood. Glue five metal disks to each piece of wood mirror image of each other. Put 4 marbles and 1 spring in the metal disks. For the mass damper design, put a sphere like a chapstick container filled with brass hanging on a string in one building. For the roof-floor ropes, tie down another building to the 8 by 8 piece of cardboard. For the isolation device, glue four glass marbles to one end of the four pieces of balsa wood and glue four empty sphere like chapstick containers to the 6   by 6   piece of cardboard. For the control make no changes.

Results

The results found were the roof-floor ropes placed first with the all together sway being 42mm. The mass damper placed second with an all together sway being 50mm. The isolation device placed third with the all together sway being 69mm. The control placed last with the all together sway being 72mm.

Conclusions

The hypothesis was supported in that if the roof -to- floor ropes are properly secured, then the building should sway 5mm less than the mass damper, isolation device, and the control. The importance of this project was to show which structures are more stable than others when an earthquake occurs. I feel that this project would benefit Structural Engineers as well as people who live and work in these buildings.

Summary Statement

Earthquake proof buildings are hard to design, and in this project, different designs were tested to see which structure would be the strongest against Earth's forces.

Help Received

Father, Joe Kilmer-engineer help; Mrs. Gastello, Science Teacher; Mom, board design and emotional support.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Talha Mala

Project Number

J0318

Project Title

Follow That Sun! How Does the Output of a Solar Tracker Vary from the Output of a Solar Panel?

Abstract

Objectives

Objective/Goals: This project was designed to discover if solar panels output could be improved.

Methods

Materials and Methods: I programmed the code for my Arduino and installed a power shield on Arduino. Then I installed servo motors so they could turn. Then I connected the four resistors and four photoresistors with the terminal block. Then I placed all the wires onto the breadboard. Then finally I connected the wires to the solar panel so I can fire it up. In the end, my solar panel and solar tracker were finally built, and they were ready so I could do my experiment.

I programmed the codes for the two of my Arduino. The codes were written in C++ format.

Results

Results: My study showed that solar trackers are about 35% more efficient than solar trackers. The average amount of milliwatt hour generated by my solar tracker was 10,212 milliwatt hours. The average for my solar panel itself was 6697 milliwatts hour.

Conclusions

Conclusion: My study is important because it helps us understand the dynamics of solar panels and improve their efficiency. The use of solar energy is growing rapidly, and we must further our research in this area to meet the demands of consumers.

Summary Statement

My project is to see if solar trackers produce more energy than static solar panels.

Help Received

None. I designed, built, and performed the experiments myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)	Project Number
Lakshmi Menon	J0319

Project Title

Developing a Multimodal Robotic Scoop

Abstract

Objectives

The goal of my project was to construct a computer-controlled device capable of capturing objects of varying size, shape and texture. My prototype robot, referred to as QuikScoop, consisted of a scooper and retaining basket attached to independent servo motors that could be programmed for a variety of motions. I hypothesized that most objects could be captured using a quick tapping motion but that other modes might be more efficient depending on the type of object.

Methods

I created a scoop and basket device from craft sticks and servo motors. I mounted the device onto a sturdy table-top base able to withstand the mechanical movement of the device. The motors were wired to an Arduino UNO R3 and controlled via USB connection to a computer that ran the corresponding application. The rotation and speed of the motors that controlled the scooper and retainer were programmed from code I wrote in Arduino. By varying the parameters in the code, I learned that simple modifications uploaded to the processor resulted in widely varying motions. This made it possible to develop several configurable modes of QuikScoop to test. I performed multiple tests on various objects, including a ping-pong ball and a Koosh ball. I measured the efficiency of capture in terms of the time between activating the button on the Arduino board to securing the object inside the retaining basket.

Results

Using this method, I found that variations on a basic tapping motion were successful for both test objects. For the ping-pong ball, the most efficient mode for capture was QuikTap, where the speed of the motor was increased just as the servo approached the object, then rapidly returned to its initial position. The most efficient mode to scoop the Koosh ball was QuikFlick, which began with a slow sweep followed by a rapid increase in the speed of rotation just prior to impact with the ball, then a gradual rotation back to the starting position.

Conclusions

Overall, my QuikScoop robot was able to successfully capture objects of different size, shape and texture. My experiments demonstrated that the efficiency of the scooping process was dependent on the physical characteristics of the object and that I was able to program different modes of operation of QuikScoop to explore this. Potential applications of QuikScoop include a robotic aid for disabled individuals to grasp items that are otherwise inaccessible.

Summary Statement

I designed and constructed a robot that could be programmed with multiple configurable modes for scooping small objects.

Help Received

I would like to thank my parents for helping me obtain all necessary materials.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Nadine Paula Ngo; Aasees Kaur Sandhu

Project Number

J0320

Project Title

The Smart Socket

Abstract

Objectives

The purpose of this project is to design an above-the-knee prosthetics that would allow amputees to move comfortably without having to worry about prosthetic-inflicted irritations/sore and the cost.

Methods

Created a silicone mold (from store-bought silicone) and a homemade papier-mache mold of the thigh, covered exterior with nitinol sheets and interior with memory foam, cut 4 slits of equal widths and lengths, attach rollerblade buckles across each slit and cover each slit on the inside with fabric to cover existing gaps. Put weights of various pressures to test durability and expanded and contracted the socket for adjustability test.

Results

The final design of the prosthetic socket was able to hold 63lbs of pressure without changing its shape, which surpassed our 40lb requirement. It was able to expand over 25 inches in circumference and 15 inches at its smallest. All of the materials were synthetic, which meant that it wasn't biodegradable (sustaining its durability).

Conclusions

The socket we created is able to distribute the weight of an adolescent on both legs while being cost-effective through repeated trials. In addition, the socket attains to the adjustability test of having the ability to increase or decrease its size, benefiting growing individuals of various sizes.

Summary Statement

Our project is about designing a low-cost, adjustable prosthetic socket that can distribute weight evenly.

Help Received

We designed the prototypes out of a combination of store-bought materials and materials we created ourselves, with minor informational help from Kaiser Permanante.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Alexander Nguyen

Project Number

J0321

Project Title

Exoskeleton Actuation

Abstract

Objectives

For this project, I constructed a motorized arm attachment that will aid in carrying loads. It is a continuation of last year's science project to implement the motorized or actuation of an exoskeleton. By having a small motor perform the heavy lifting, this extension of the body opens a whole new spectrum of possibilities. The chassis can be used for multiple purposes by helping the paraplegic people move or rehabilitate the injured. Creating a fully motorized exoskeleton to gain superhuman capabilities is a arduous task, to say the least. The project's main goal is to use servo actuation to aid a person lift 10 pounds of load and remain somewhat comfortable. The design used gear arrangements to create torque. It was important to create maximum torque for a given servo motor and maintain the smallest size possible. Also, safety and precautions such as reinforcing where the joint should stop were imperative. If the motor for some reason decided to continue to move in a way the arm does not normally move, the user would not end up with a broken arm.

Methods

Constraints of costs, time, work skills and safety were some of the main roadblocks. I could not purchase expensive materials, so I had to use materials that are readily available around the house and home depot. All of the parts could not just be 3D printed and they had to be fabricated by hand. Wood, aluminum and servo motors were used. Getting supplies, designing and assembly were chunked out over long periods of time

Results

To test the effectiveness of the arm, multiple combinations of weights were loaded onto the forearm. The weights ranged from 3 pounds to 11. The arm was held down by a helping hand and it was determined if the arm could lift it from the bottom up, or not. The minimal voltage needed to lift the weight was also measured. The Vex 393 servo motor had a thermal breaker installed to stop the motor before it ever gets close to its limit, so the system can only lift the maximum of 11 pounds. I also tested the relationship between current and weight.

Conclusions

In the end, the project was a success. The arm lifted to 11 pounds on its own before the thermal breaker kicks in and cuts the current to the motor. The next step is to improve and refine the exoskeleton actuation by replication the motorized arm for all other joints. A harmonic gear could be used to reduce the size and increase the torque. The motor and the chassis can be sized down, so that it would not be too heavy and

Summary Statement

I designed, built and tested a geared and servo controlled arm joint of an exoskeleton suit.

Help Received

I researched, developed concepts, designed, built and tested the servo controlled arm joint of an exoskeleton suit by myself. My dad taught me about the design process, how to research to learn about mechanics, dynamics, and servo motors. I also researched about DARPA projects.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Alex Nikolian

Project Number

J0322

Project Title

R.O.E.D. (Robotic Ocean Exploring Device)

Abstract

Objectives

Ever since I was a little kid, I loved our oceans, but as I got older, I realized how little we have discovered about them. Our oceans cover 70% of the Earth's surface, and mankind has only explored a measly 5% of that whole. This means that there is still 65% of Earth's surface that we have not explored, and 95% of our oceans have not been touched by mankind, so I created R.O.E.D.

Methods

R.O.E.D. is made up of three main parts: the body, electronics, and the tail fin. The shell of the body is made up of seven 1/4 inch by 3 feet wooden planks and seven 1 inch by 3 feet wooden planks. The shell is basically the foundation of R.O.E.D., and it holds all the electronics in it. The shell is later wrapped with fiberglass cloth, which is later brushed with Epoxy. To make the primary dorsal fin and the two pectoral fins I used high density polyethylene sheets and cut them out to my desired shape. The electronics include a 30 kg waterproof servo, two Savox waterproof servos, 6 volt battery and a 7 volt Lipo battery, Spektrum receiver and transmitter, Prophet Sport Mini 50W Multi-Chemistry battery charger, and a 6 inch standard reverser. These all play a part in the movement of R.O.E.D. The tail was made with high density polyethylene sheet, a hinge, L shaped metal piece, a one sided servo topper, and a 1 foot aluminum rod.

Results

After testing R.O.E.D., I noticed that the movement truly works and it is all waterproof. The average velocity was 0.107 m/s and the average acceleration was 0.002 m/s squared. This means that the shark's unique movement is possible to replicate and can be used in sea exploration devices, like mine.

Conclusions

Based on my results I found that I was able to replicate the shark's unique movement. Though, the results that I found were not quick and that efficient. I will now try to make my device quicker and much more of an efficient tool. R.O.E.D.'s shape and movement style can help further our knowledge about marine biology. The shape will allow marine animals to be more comfortable around my device because of its fish like depiction. This will allow marine animals to interact with my device like no other device has ever done.

Summary Statement

I created a sea exploration device that is based on the shape and movement of a shark.

Help Received

I designed and created R.O.E.D. on my own. I received help from my father who taught me the basics of engineering, like foundations.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Quinn Olson

Project Number

J0323

Project Title

Shock Absorption: Can You Feel It?

Abstract

Objectives

The objective of this project is to test materials that can be used as padding in baseball or softball gloves, to potentially improve protection and reduce injury.

Methods

The materials tested included Felt (which is used in most gloves), Sorbothane (a specialized shock absorbing material), Neoprene (a synthetic rubber sometimes used for protection), and Silicone.
Two types of experiments were completed. The first was a shock absorption test, measuring the bounce height of a ball dropped onto the different materials. The second experiment used a pressure-sensitive film to measure the impact pressure and the spread of the impact over the surface.

Results

In the shock absorption experiment, the Sorbothane had the lowest bounce, meaning it absorbed the most energy. The felt absorbed the least energy. In the second experiment, the silicone performed the best. It spread the impact the most, which reduced the maximum pressure at any particular spot.

Conclusions

All three alternative materials provided more protection in my tests than the felt that is typically used in gloves. This is evidence that a more protective baseball glove could be made.

Summary Statement

I showed that baseball gloves could be more protective by using padding materials that absorb energy and spread the impact of the ball.

Help Received

My family members assisted by operating the slow motion camera, helping me learn the physics concepts, and proofreading.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Joseph Pelz

Project Number

J0324

Project Title

The Effect of Suspension on Jumping a Mountain Bike

Abstract

Objectives

The goal of this project is to find what pressure I should have in myth rear shock on my mountain bike that will allow more hang time and distance traveled.

Methods

Full suspension mountain bike
4 ft jump.A camera that was able to record well. I used a Garmin Virb Ultra 30. A computer with software that can view your cameras files.

Results

These results show a connection between the stiffness of the rear shock and airtime on a bike jump. The average airtime with a stiff rear suspension (135 PSI) was 3.3 seconds. That was longer than the lower pressures (130 PSI = 3 seconds and 125 PSI = 2.6 seconds). The squishier suspension definitely helped cushion the landing, but it lowered the airtime and distance traveled for the bike jump.

Conclusions

I think I have enough data to make a strong conclusion. I did ten tests for each pressure per square inch (PSI). However I only tested three different pressures (125,130 and 135). If I had tested a wider range of pressures, or tested on different jumps, and I would have more data and could make a stronger conclusion.

Summary Statement

Its about how changing the pressure in you rear shock affects the airtime and distance traveled while jumping your mountain bike

Help Received

Name(s)

Nicholas Saldavia

Project Number

J0325

Project Title

Fallen Arches: The Surprising Strength of Eggshells

Abstract

Objectives

I wanted to learn if the strength of an arch decreases as the size of an arch increases.

Methods

Eggshells have a naturally occurring arch shape. I used different sizes of eggshells to test the strength of different sizes of arches. I began with large, extra large, and jumbo eggs. Each egg was cracked, emptied, and the shell was cut in half. I then placed three of the half eggshells on a flat surface and gently stacked books on the shells until a shell cracked. The books were weighed on a kitchen scale to determine the mass it took to break the shell.

Results

I chose three different size eggs to represent three sizes of arches. The egg sizes were large, extra large, and jumbo. I completed five trials on each size for a total of fifteen trials. The large and jumbo eggs were brown and the extra large eggs were white. The large eggs held an average of 10,631 grams, the extra large eggs held an average of 8,984 grams, and the jumbo eggs held an average of 10,346 grams before breaking.

Conclusions

My results did not support my hypothesis. They were inconclusive. There was only a small difference in the mass each of the eggshell sizes could support. I believe this occurred because the eggshell sizes I tested were too similar in size to make a significant difference in the amount of mass they could support. I did learn that an arch, even made of eggshell, can be very strong.

Summary Statement

I wanted to test the strength of an arch by using the naturally occurring arch shape of an eggshell.

Help Received

I received help from my parents, Sean & Nicole Saldavia, and my teacher, Mrs. Arghavani.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Brianna Vu

Project Number

J0326

Project Title

The Textile Strength of Homemade Bioplastic

Abstract

Objectives

Our ecosystem is suffering from a major problem that includes only one thing: plastics. Plastics tarnish our air and cause damage to many sea creatures. Well that is a problem that needs to be fixed. The purpose of my science fair project is to find an alternative for plastics that will not harm the environment. Instead, it will help the environment thrive from it. Plastics are harming our present day world more than anything, and I am trying to find a way to stop this by making a substitute for plastics. My question for my project is "Which alternative bioplastic mixture will be the best replacement for plastics?"

Methods

First, I created 20 bioplastic samples, 5 samples of each material made. Meaning, I had 5 samples for corn, potato, tapioca starch, and agar. After the bioplastic process was complete, I cut them all into equal sizes, dimensions, and lengths to test their strength. To test their strength, I drilled a hole in the center of the sample and attached a ribbon to it. I than had a hanging scale where I would pull on the sample onto the scale until the sample would break. The scale would give me the amount of weight that I applied in order to break the sample. The weight of the sample signifies how much weight was needed in order to break the sample. I than repeated the strength method for all of the samples and averaged out their average amount of weight/strength in order to break the sample. I also included temperature for a diversity in strength testing of the bioplastic.

Results

I averaged the amount of strength required to break the sample at each temperature. At 21oC, tapioca had an average strength capacity of 2.3 kg per cm, agar had 6.8 kg, corn had 5.0 kg, and potato had 3.6 kg. At 3oC, tapioca had an average strength capacity of 2.6 kg per cm, agar had 7.5 kg, corn had 6.4 kg, and potato had 3.7 kg. At -15oC, tapioca had a strength of 3.8 kg per cm, agar had 9.3 kg, corn had 8.9 kg, and potato had 4.5 kg. At 38oC, tapioca had a strength capacity of 3.6 kg per cm, agar had 5.4 kg, corn had 5.0 kg, and potato had 2.4 kg. Lastly, at 66oC, tapioca had a strength capacity of 2.8 kg per cm, agar had 3.1 kg, corn had 3.4 kg, and potato had 2.2 kg. In the end agar performed the strongest, than corn, potato, and tapioca starch.

Conclusions

In conclusion, my hypothesis was incorrect! My hypothesis stated: If I were to make 4 bioplastic mixtures using agar, starch, potatoes, and corn, then the corn would be the strongest because it is a commonly used bioplastic substance that is already manufactured. Agar turned out to be the strongest compound out of all 4

Summary Statement

To help save our environment, I created a bioplastic substance from naturally occurring materials and tested their strength to see which substance performed the strongest.

Help Received

Throughout this project, I have been lucky to have such a supportive teacher who is always willing to help me out whenever I would need it. My family has always been by my side and I appreciate that the most. Lastly, I presented to some seniors for presentational advice.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Bryce Wong

Project Number

J0327

Project Title

Give Your Back a Break: Improving Backpacks through Biomechanics

Abstract

Objectives

The objective of my project was to develop a backpack that improves proper body alignment while reducing the compression on the shoulders. Backpacks induce distortion of the natural curvature of the spine and impair the musculoskeletal health of the body. Numerous scientific studies, reports, and interviews of medical professionals in the USA and other parts of the world have indicated that thousands of children experience discomfort and pain when carrying heavy backpacks.

Methods

I designed my backpack considering the biomechanics of the body in the key components such as well-padded, molded shoulder straps for broader distribution of load, a hip belt to support the lumbar, a rigid framework to provide structure, and shelves to place the backpack's center of mass closer to the person s body for balance. I compared my prototype against five commercial backpacks. To measure compression forces on the shoulders, I used load cells made of flour dough on a dummy s shoulders and measured and compared the deformation. I determined load distribution in different configurations by using a luggage scale on each shoulder. I measured the center of mass location relative to the back and to evaluate comfort level and areas of strain I wore the backpacks with a blindfold.

Results

The tests indicated that my prototype was better than the commercial backpacks. Some of the results were: 74% of the thickness of the load cells on my prototype was preserved compared to 40% average for the others. Circumference of the compressed load cells increased by just 1.5cm - 2.5cm wider on my prototype compared to an average of 4.74cm - 5.5cm for all others. For the load distribution on the shoulders, my prototype showed less weight on the shoulders with results comparable to the commercial backpack that has a hip belt. For the center of mass location, my prototype measures was 8cm to the back with the sports backpack as second closest. For the blindfold test, my prototype overall showed less strain felt on the key areas of the body.

Conclusions

I can conclude that with all the components integrated into my backpack design, it reduces the strain and pain caused by carrying heavy loads. Also, with the hip belt attached to the shoulder strap, the wearer is required to use the hip belt. The promising results of my design could be the new driving force for backpack manufacturers to incorporate the importance of biomechanical engineering in their products. Furthermore, I hope that more people will understand that using ill-fitted and poorly designed backpacks can affect their

Summary Statement

I designed a better backpack that reduces compression on the shoulders and minimizes back strain associated with carrying heavy loads.

Help Received

I personally interviewed Dr. Nakano, DC who helped me understand some medical terms and my dad who helped me during the blindfold test.